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Source: *Journal of Anthropological Research* , SPRING 2011, Vol. 67, No. 1 (SPRING 2011), pp. 77-102

Published by: The University of Chicago Press

Stable URL: https://www.jstor.org/stable/41304120

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The Contribution of Ethnographical Studies to Research on Mesolithic and Early Neolithic Technologies in Northern Spain

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KEY WORDS: Shell tools, Ethnography, Technology, Archaeomalacology, Functional analysis, Hunter-gatherers

In European archaeology, the malacological remains recovered in archaeological contexts have traditionally been considered almost exclusively as food waste. In other cases, this view has been broadened in order to study these remains as an expression of aspects of the social organization of the human groups, based on the use of perforated shells as objects of personal ornamentation. However, the study of these natural resources as raw materials for the manufacture of tools aimed at satisfying the production needs of the human groups has been very limited. This little-developed aspect of research is at variance with the abundant ethnographic information from many different periods and geographical settings showing that malacological resources were used in many complex and varied ways. This paper is an attempt at compiling a small part of this ethnographic information—a contribution which, through its critical application to the archaeological record, is of interest in establishing a methodology for studying this type of evidence. In the specific case of northern Spain, information from ethnographic studies has been used to develop an appropriate methodology with which to approach the analysis of this kind of archaeological evidence, as recently documented for the first time at the classic site of Santimamiñe (Basque Country). At the same time, the documentation of shell tools could provide an explanation for the scarcity of "traditional technologies" that characterizes many Mesolithic and early Neolithic sites in northern Spain.

GATHERING AND CONSUMPTION OF MALACOLOGICAL RESOURCES BY COASTAL HUMAN GROUPS

The malacological remains found in archaeological contexts have generally been studied from the viewpoint of accumulations produced by gathering activities aimed at satisfying nutritional needs. This use as a food source may be thought

Journal of Anthropological Research, vol. 67, 2011

of as the first step in the consumption of this natural resource. However, in some contexts (such as in Jamaica, the Bahamas, and Haiti), it has been shown that molluscs were gathered in order to be used as the raw material for making tools. For example, whole *Strombus gigas* shells were carried from the coast to the inland settlements where they were found in substantial accumulations, which is significant given the relationship between the weight of the shell (some 2 kg on average) and the small amount of meat inside (only 150 g; Jones O'Day and Keegan 2001). In addition, the meat could have been taken out at the shore.

However, the use for ornamental purposes of shells from molluscs too small for use as food, together with shells gathered on beaches to be used for making tools, show that the chain of consumption does not always follow the traditional model of food first, and adornment/implement second.

In order to gather molluscs it is only necessary to have knowledge of the tides and the basic tools for collecting and transporting the shells (Cuenca 2009; Gutiérrez Zugasti 2008; Gutiérrez Zugasti et al. in press). In general these implements are considerably less elaborate than the tools used in other productive activities, such as hunting (González Morales 1982). In addition, because of the stable and reliable nature of this resource and the variety of complementary uses to which molluscs can be put, mollusc exploitation is common to almost all human groups who obtain their resources in coastal regions.

In any case, despite the difficulties in confirming the consumption of molluscs by human groups in very early periods of prehistory, the oldest evidence of their technological use may be associated with *Homo erectus*, about 1.5 or 1.6 million years ago, at the site of Sangiran in Indonesia (Choi and Driwantoro 2007). Here, tools made from shells (*Bullidae*, *Veneridae*, *Carditidae*, *Anomiidae*, *Littprinidae,* and *Fasciolariidae*) are thought to have been used in butchery activities. The earliest possible evidence of consumption of marine molluscs in Europe has been suggested at the site of Terra Amata, which dates to about 300,000 years ago (de Lumley 1969).

It is quite common to find potentially socially meaningful artifacts made from shells, as is evident in the perforation of the shells of various species in order to make beads, pendants, or other adornments. There is no doubt that this resource is important in the economy of human groups in coastal contexts, either as a source of food, as tools, or for decorative, artistic, or social purposes. In this sense, regardless of how they were consumed, molluscs are a natural resource that is transformed into a social resource through the work that incorporates them into social production (Gassiot Ballbè 2001a, 2001b, 2002). Such work can range from their extraction from a muddy estuary bed to their transport from the shore to the settlement and subsequent preparation to be eaten or modified to be used for such purposes as tools, adornments, or grave goods.

USE OF SHELL TOOLS IN PRODUCTIVE ACTIVITIES

Shell tools, like all other artifacts made from animal raw materials, can be used in productive activities in one of two ways according to their morphological and physical properties. Either the resource (in this case, a shell) is used in its natural state, without altering its original form (Binford 1998), or it is subjected to various modification processes. The former case may reflect expedient use, whereas shells modified for use can be called formal tools, provided that use-wear marks confirm such a use. The recognition of these models of indirect consumption of these marine resources depends mainly on the morphology of the marine species being used, as well as the activity for which it will be used. The modification generally has the objective of improving the usefulness of the instrument or adapting it to activities for which its original morphology is not suitable. For example, in an experiment, Toth and Woods (1989) used *Ostrea* shells to process the carcasses of *Capra hircus* and *Odocoileus virginianus*. They showed that unmodified oyster shells were inefficient for this task, but when they used shells with retouched edges they were able to carry out the butchering efficiently.

Therefore, the manufacturing of formal shell tools generally consists of transforming natural edges into cutting edges by removing part of them or by retouching them in different ways (marginal, inverse, scalariform, and so on). On other occasions, the different anatomical parts of the shell are separated, mostly by percussion. Modifying shells to be used as tools is more common on large species, whose size and shape allows each part to be used in a different way, so the shell is prepared for specialized and/or differentiated activities. Occasionally, evidence of these production processes can be traced in settlements where these types of activities have been carried out (Jones O'Day and Keegan 2001), in a similar way to other kinds of raw materials, such as flint used to manufacture lithic tools. Some scholars refer to this type of artifact as a "nucleiform," indicating the use of large gastropod shells as raw material for shaping flakes (Prous 1992). Species that could exhibit differentiated use of anatomical parts include *Strombus gigas, Amiantis umbonella, Meretrix* sp., and *Callista erycina.*

Unmodified mollusc shells, like bones, have no suitable edges for cutting, so they become blunt and lose their effectiveness very quickly. They would have to be resharpened constantly if they were used for cutting. They are much more effective for carrying out transverse actions, such as scraping and planing, and for percussion (Clemente 1995, 1997; Cuenca 2009; Gutiérrez Zugasti et al. in press; Mansur and Clemente 2009). In this respect, tools used for activities with transverse kinematics are generally expedient (unmodified), since their natural shape enables them to be used effectively without further modification. When the tool loses its functional potential, it can easily be replaced with a new one.

To date, none of the technological or archaeomalacological studies carried out in numerous coastal contexts, particularly in Europe, has developed an appropriate approach to the study of shell technologies, despite the abundant information available from both ethnographical and archaeological studies (the latter based mainly on use-wear analysis) on the use of mollusc shells as tools. This type of research has been developed in much greater depth in geographical areas with a long tradition in the use of these kinds of tools, and whose cultural heritage has reached practically the present time, through the descriptions made by anthropologists and ethnographers. This is the case of South America and Central America, as well as numerous locations in the Pacific.

Analysis of the corpus of information on the technological use of shells indicates that the traditional view that molluscs were exclusively food resources is biased, or at least incomplete, as some scholars have suggested for European sites (Cade 1991; Cristiani et al. 2005; Dupont 2006; Gruet 1993; Vigié 1987, 1992, 1995; Vigié and Courtin 1986, 1987). This is especially true if we take into account the many, varied archaeological contexts, in different latitudes of the Pacific, Mediterranean, and Atlantic (e.g., Córdova Medina 1991; Dacal Moure and Rivero de la Calle 1984; Guarch 1973; Izquierdo Díaz 1991; Jerardino 1998; Jones O'Day and Keegan 2001; Mansur and Clemente 2009; Marquardt and Payne 1992; Méry et al. 2008; Moore 1921; Smith and Allen 1999; Szabó 2008; Szabó et al. 2007), which suggest molluscs were used not only as a food resource but as the raw material to produce tools.

ETHNOGRAPHICALLY DOCUMENTED USE OF MOLLUSC SHELLS

Many types of tools made from mollusc shells have been used historically by numerous human groups exploiting coastal environments. Some researchers have pointed out a differential use of gastropods and bivalves. Gastropods have been used as spoons, money, anvils, plates, glasses, weights for fishing-nets, mills, cups, gouges, hammers, spindles, and knives. Bivalves have been employed as knives, borers, and scrapers, among other uses (Claassen 1998:201).

Knives

Among the tools used in productive activities, we find shells used expediently as knives or as the raw material to make handled knives of different kinds (formal tools). In this respect, the use of *Unio* shells (freshwater mussels) as knives has been documented at Hokkaido (Leroi-Gourhan 1945), while the Naujamiut of Greenland used *Ostrea edulis* shells to cut and scrape seal skins. In a similar way, Eskimos from Alaska used shells to cut the entrails of marine mammals (Dupont 2003).

This kind of use has been well documented for the Yámana (Yaghan) from Tierra del Fuego. The knife-scrapers made by the Yámana had four parts: (*a*) the mollusc valve sharpened by abrasion, (*b*) an elongated beach pebble used as a handle, (*c*) a strap used to attach the handle to the shell, and (*d*) caulk or moss used to cushion the handle to soften the blows, and to retard breakage. This artifact was employed in many different activities: as a hatchet; to scrape; to carve wood; to cut up meat, wood, bone, or hide; or even to cut the umbilical cord of newborn babies (Gusinde 1986; Mansur and Clemente 2009). To carry out more delicate work in wood, bone, or hide, the Yámana also used *Tagelus* shells (Gusinde 1986).

Other aboriginal groups in Tierra del Fuego, such as the Selk'nam, are also known to have used tools made from mollusc valves prehistorically. In this case, *Mytilus* valves were used to make knives, which were later turned into scrapers (Mansur and Clemente 2009).

Similarly, in Brazil, we know that several bivalve species were used to make knives, including *Lucina/Phacoides*, *Mytilus*, *Mactra*, *Macrocallista*, *Ostrea*, and *Diplodon*. These knives were used to cut materials such as meat or wood.

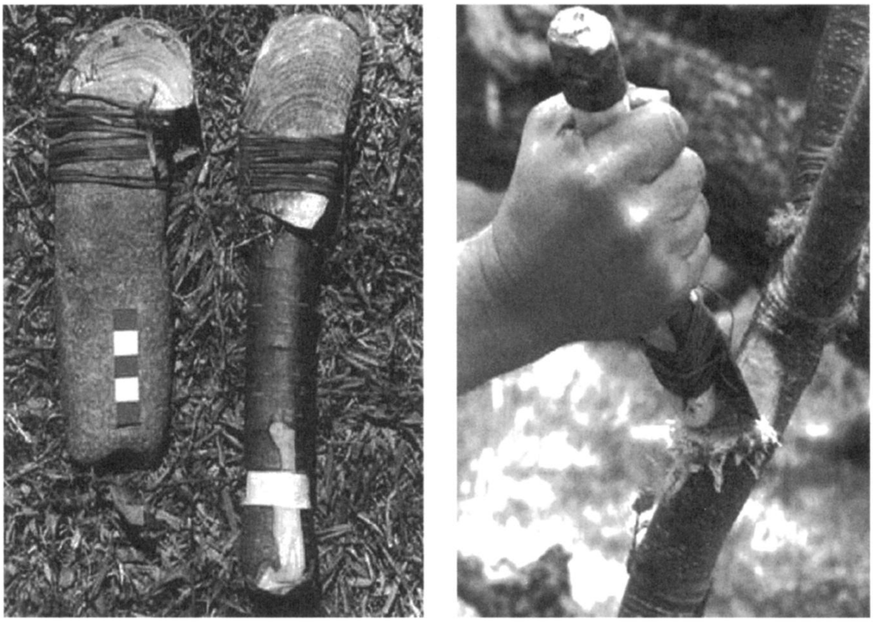

Figure 1. Experimental knife-scrapers Yámana (from Mansur and Clemente 2009).

The knives made from Lucinidae shells were prepared by making continuous denticulations between 2 and 3 cm long along the shell rim. In the same area of Brazil, the prehistoric culture known as the Sambaqui of Guaraguaçu used *Ostrea* shells; the Kamayura of Buraçao used them to open manioc, and the Humutima (Umatina) and the Bororo cut hair with them (Prous 1992). Emperaire (1958) documented several different uses of molluscs among the Alacaluf in Chile. They used *Mytilus* shells as knives in butchery tasks, employing the sharp edges. In the area of the Jerónimo Channel, *Mytilus* shells were sharpened with stones in order to cut hard firewood and bone (Emperaire 1958). In this area, the "choro" or mussel is quite common and is gathered by groups living on the coast. Nomadic groups on the coast of Chiapas (Mexico) also made various tools, including knives, with the shells of various molluscs (Linares Villanueva 2005).

The Patwin in the southern Sacramento Valley of California also used mussel shells and knives to cut and descale fish, and to cut meat (Johnson 1978:357).

Scrapers

Many of knives described above, as well as being used in cutting activities, were used for scraping; an example is the multifunctional knife-scraper of the Yámana.

Some of the most common scraping activities carried out with shell tools are tasks involved in treating hides and, as is logical for groups exploiting coastal areas, in processing fish. For example, the Chugach Eskimos in Alaska used molluscs to remove the scales from fish (Dupont 2003). In an analogous way, the use of mollusc shells to scrape bark to make fiber has been documented in Polynesia

(Leroi-Gourhan 1945:215), and *Mytilus* scrapers were used in Tierra del Fuego in hide-processing activities, with the mussel strapped to a pebble as a kind of handle (Leroi-Gourhan 1945:219). In Brazil, several types of shell scrapers have been documented. Side-scrapers were made from species such as *Tinela ventricosa* and *Macrocallista*, retouched to form a straight or slightly convex active edge, one that is more abrupt and robust than the shell's natural edge. These types of scrapers were often used by the Itaipu, who lived on the shore near Rio de Janeiro. They were also used by the Waura to smooth their pottery before it was fired (also see below). Other kinds of scrapers are concave or notched, with the active part retouched obliquely. These are normally used to shape cylindrical wooden or bone staffs (Prous 1992).

The Alacaluf also used shells to scrape and thin seal and otter skins (Emperaire 1958). Similarly, around the Gulf of Mexico, prehispanic groups made scrapers with different kinds of mollusc shells (Linares Villanueva 2005). In Cuba, bivalve shells were used to scrape manioc root (Dacal Moure and Rivero de la Calle 1984).

Finally, mollusc and gastropod shells have also been documented as side-scrapers. The most common types were made from hard *Strombus* and *Spondylus* shells, although occasionally *Pecten* shells were employed as well, using their natural toothed edge (Suárez 1974). This type of use has been documented among various groups in Venezuela.

Hooks

Numerous groups have used mollusc shells to make fishing hooks. They have been documented in such areas as Oceania, Polynesia, and Melanesia (Leroi-Gourhan 1945:168).

In Brazil the genus *Strophocheilidae* is generally used, separating the body or the reinforced lip, which is then polished and used for fishing (Prous 1992).

The Obispeño and Purisimeño of the Chumash cultural group, an indigenous people of California, fished with net weights and hooks made from shells (Greenwood 1978:521). The net weights were generally made from large species, such as *Strombus* and *Busycon*; this use is also known for indigenous groups in what are now New York and Ohio, as well as elsewhere in California (Suárez 1974). Some groups, such as the Alacaluf of Chile, used some molluscs as bait (Emperaire 1958); this use has also been documented among the Yámana on Tierra del Fuego, but in that case they fished without hooks (Gusinde 1986).

Similarly, on the islands of Polynesia, hooks made from small *Trochus* and *Turbo* shells (between 13 and 30 mm) were used by the aborigines from the fourteenth century (Allen 1996). In general, these artifacts made from shell are very common around the Pacific, and in northeastern North America, whereas in Central America the use of nets and arrows appears to have been predominant (Suárez 1974).

Polishers and Smoothers

Mollusc shells were also used to polish various materials, For example, in South America, the Guayaquís (Ache) Indians use freshwater bivalve shells in the final stage of polishing axe handles, and in several parts of Africa they are

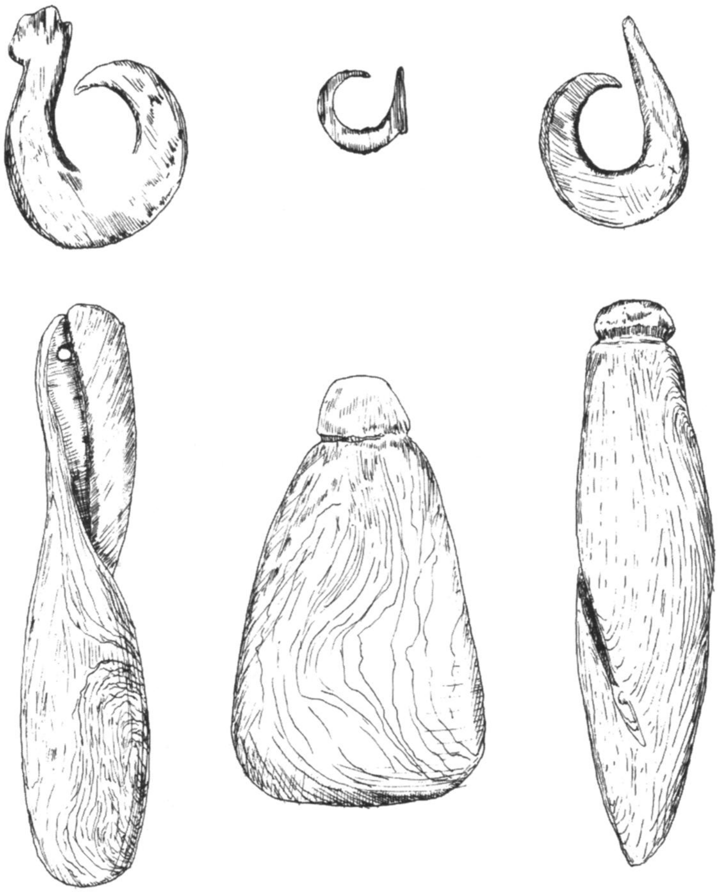

Figure 2. Example of shell hooks and net weights (from Suárez 1974).

used to smooth ceramic vessels (Dupont 2003). This use, for smoothing pottery, has also been documented ethnographically in the Canary Islands (Rodríguez and Navarro 1999).

In Brazil, unmodified *Strophocheilidae* shells were used by the Bororo to polish their wooden bows (Prous 1992). The Alacaluf worked bone with shells, holding the broken convex face and using the edges of thick shells to polish the heads of harpoons (Emperaire 1958:233).

Gouges, Adzes, and Other Woodworking Tools

In Chile, the Alacaluf used shells as woodworking gouges to build their boats (Emperaire 1958). They hafted shells on handles and used the cutting edge to prepare tree bark for canoes and also to shape the oars. Various species were also used to plane the wood and for the final effect. They made wooden hooks, using sharp shells; with the arrival of Europeans, these were replaced by metal blades (Emperaire 1958).

Another similar implement, although smaller, has been documented among aboriginal groups in Brazil. These are micro-gouges, generally made from small bivalve shells, with the anterior or posterior edges retouched to form a right angle, or slightly vertical concave or concave in transverse section. Some of these artifacts are made from *Diplodon* shells, between 6 and 8 cm long, by direct retouching of the dorsal face, causing flaking on the ventral face (Prous 1992). In Brazil, saws were commonly made with mollusc shells. Robust shells were used, of species such as *Lucina*, *Mactra*, *Macoma*, and *Macrocallista*, modifying the edges by retouching at regular intervals. These tools could be used as saws or for scraping (Prous 1992).

In Oceania, mollusc shells were widely used as adzes or axes. They were employed for various functions, including woodworking (Leroi-Gourhan 1945).

Punches and Borers

In Brazil, shells were also used to make punches—tools with a straight, sharp point. They are normally used by applying pressure, often with rotation, so their use may leave oblique use-wear marks. They are usually made from such species as *Macrocallista*, *Maculata*, and *Strophoenelidae*. Naturally pointed *Ostrea* fragments may also be regarded as punches (Prous 1992). Spines of sea urchins (*Echinoidea*), for example, were used as drills by the Ainu of Hokkaido, in the northern Pacific (Leroi-Gourhan 1945:153).

Borers made from shells are documented for the proto-agricultural stage in Cuba. To manufacture these tools it was necessary to shape the shell by light percussion (Dacal Moure and Rivero de la Calle 1984).

Weapons

Two types of weapons made from shells have been documented ethnographically: projectile points and clubs. These artifacts are mainly found in places where lithic raw materials are not abundant or of poor quality (Suárez 1974). For example, in Brazil, arrowheads are known to have been made with *Ostrea* and used primarily in the area of the Bay of Paranagua and Cananéia. They are pointed objects, some of which possess a small tang (Prous 1992). Similar projectile points were also used by the Brownsville culture on the coast of Tamaulipas, near the modern border between Texas and Mexico (Suárez 1974:22).

Clubs were made from thick shells, such as *Busycon perversum* and *Strombus gigas*, which were hafted to a transverse handle. These artifacts have been documented in Florida and on the Atlantic coast of North America (Súarez 1974:22).

Other Tools

The Guayaquis (Ache) in the tropical rainforest of Paraguay used freshwater bivalve shells to spread the wax that protected the sides of the baskets they used for gathering (Dupont 2003). In Brazil, the seringueiros (rubber-tappers) in the Amazon forest used *Ampullaria gigas* shells to collect rubber latex.

Both shell axes and hammers were generally made from the mantle of thick gastropod shells; in some cases they were hafted but in others they were used expediently. They have been documented in Vancouver, New England, Florida, and also in Honduras (Suárez 1974). In Chiapas on the Gulf of Mexico, hammers were made from the shells of large gastropods (Linares Villanueva 2005).

In the same way, we know that some groups used large gastropods as ards or plowshares, with little modification of the shell. On occasions, with a wooden haft, the lower part of the labrum was used as an ard. Another type was made from clam valves tied with a cord. These objects have been documented only for societies in the initial stages of agriculture (Suárez 1974).

Finally, some groups of aborigines depilate practically their entire body and even cut their hair with shells. For example, among the Yámana of Tierra del Fuego, *Mytilus* shells were used as pincers for depilation (Mansur and Clemente 2009). This use is also known among the Alacaluf in Chile (Emperaire 1958). In many cases, the valves were tied together with a cord through the area of the umbo; this type of artifact has also been documented over much of North America.

MESOLITHIC AND EARLY NEOLITHIC TECHNOLOGIES IN SHELL MIDDEN SITES IN NORTHERN SPAIN

One of the debates that has arisen as regards the Mesolithic in northern Spain focuses on the scarcity of artifacts found in certain contexts, especially in the western part of the region (Arias 1992a; Clark 1976; González Morales 1982; González Morales et al. 2004; Vega del Sella 1930). However, the relative scarcity of lithic and bone technologies at these Mesolithic sites is usually based on comparison of the quantity of knapping waste or retouched implements with the numbers of artifacts found at Upper Paleolithic occupations. Despite the lower density of tools, Mesolithic shell middens still provide evidence for a similar variety of productive activities as is found at Paleolithic settlements. Activities apart from the exploitation of molluscs were carried out at the sites, such as the consumption of mammals and fish. In addition, it is common to find human remains within the middens, as at Balmori, Cuartamentero, El Molino de Gasparín, Poza l'Egua, Colomba (Arias and Fano 2003), or El Toral III. In the same way, some of these occupations display a markedly stable character, as at Mazaculos II (González Morales 1995a, 1995b).

This well-known reduction in the quantity of lithic and bone technologies at Mesolithic settlements in the western (Asturian) part of the region is also seen in general terms at sites in the eastern (Basque) sector. The assemblages of the latter area, however, are more heterogeneous in this respect. Some sites display low tool indices; in other cases the technological range might be regarded as more substantial, although still smaller than at Paleolithic sites. Note, however, that few empirical data are available since many of these sites are still being studied, and different proportions of the total surface areas have been excavated at each site. The availability of flint in larger quantities and of higher quality in the eastern sector enabled a greater use of blade technology. In contrast, at the western sites, the scarcity of outcrops of high-quality flint was counterbalanced by the use of other materials, such as radiolarite and quartzite (e.g., Straus 1996). The latter was employed to make, among other things, the Asturian picks that traditionally have been used in the chronocultural definition of the Mesolithic settlements in the western sector (generally known as the Asturian Culture).

In the early Neolithic, the period for which the technological use of shells has been documented in Cantabrian Spain, coastal sites such as Santimamiñe seem to display a higher density of lithic artifacts in comparison with the Mesolithic occupations, generally with larger numbers of geometric pieces. Thus, while coastal sites in the east, such as Kobaederra (also Urdaibai, in Vizcaya; Zapata et al. 1997) and Los Gitanos (Sámano, Cantabria; Ontañón 2005), seem to exhibit a relative abundance of these kinds of artifacts in their inventories, at an early Neolithic site in the western area, Mazaculos II (level A2) (González Morales 1995b), the presence of geometrics was limited to a single microlithic trapeze. In the same way, in the western sector, only Stratigraphic Unit 7 at Los Canes (Arias and Pérez 1992, 1995) seems to have geometric microliths in numbers similar to or greater than are found in the eastern part of the region. However, Los Canes is an inland site, where the presence of marine resources was negligible. Despite this, in the Neolithic of the western part of Cantabrian Spain, a balance can be seen between the use of quartzite (the predominant raw material in this area in the Mesolithic) and flint. This is reflected in a larger proportion of blade technologies in contrast with the predominance of macrolithic implements at Mesolithic sites (González Morales 1995b).

This lack of "traditional tools"—that is, those made from bone or lithic materials—at many shell middens in northern Spain has led to continuing discussions about the functionality and use of these Mesolithic and early Neolithic sites. Rarely is the evidence found at the shell middens clear enough to enable them to be defined as habitation sites, which has given rise to a dual debate about the technology used by these hunter-gatherers to carry out their productive activities and also about the places chosen by the human groups to perform these economic activities (e.g., Straus 1979). As regards the technology, in response to the small quantity of bone and lithic industries at certain of these sites, some researchers have suggested the use of industries made from perishable material, such as wood (Arias 1992b; Clark 1976; González Morales 1995a). Unfortunately, it is difficult to document this kind of material directly in the Cantabrian archaeological record, and the only way to trace its use is based on indirect evidence, such as use-wear analysis of the nonperishable tools that have been recovered.

Similarly, in other parts of the world, different functions have been proposed for the shell middens. Some authors have interpreted certain sites as places used specifically for the processing of malacological resources, which were then stored (Henshilwood et al. 1994). However, compared with this type of site, the Mesolithic and Neolithic middens in northern Spain occur in different locations, have different morphologies, and, above all, evidence a greater variety of productive activities, extending beyond the mere gathering of coastal resources.

In this respect, in order to suggest an explanation for the scarcity of technology with which to carry out the wide range of productive processes seen in these Mesolithic and early Neolithic sites, with the analogic support of the ethnographic information given above, the hypothesis is proposed that shell implements were used to perform some of the activities carried out by these groups of hunter-gatherers in northern Spain.

USE OF SHELL TOOLS DURING THE EARLY NEOLITHIC IN NORTHERN SPAIN: THE CASE OF SANTIMAMIÑE CAVE

Santimamiñe Cave is located in the town of Kortezubi (Vizcaya, Basque Country), on the southern slopes of Monte Erzoñar, on the eastern side of Urdaibai Valley. The cave entrance faces south-southeast and leads to a long vestibule, at 137 m above sea level. The cave was excavated between 1918 and 1926 by a team led by T. Aranzadi, J. M. Barandiarán, and E. Eguren (1931; Aranzadi and Barandiarán 1935). These researchers described a major deposit whose stratigraphic sequence covered much of the region's prehistory, as well as a magnificent ensemble of Magdalenian cave paintings. In the Upper Paleolithic levels they found evidence of the exploitation of coastal environments, which increased in importance in the Mesolithic, with a large midden made up of *Ostrea edulis, Scrobicularia plana, Ruditapes decussatus*, and *Patella* sp. as the main species. They divided this midden into two levels, based on the presence or absence of ceramics. Between 1960 and 1962, Barandiarán undertook more limited work (Barandiarán 1961, 1962, 1963) to straighten the wall of a stratigraphic section, and additional molluscs were found.

The recent stratigraphic reappraisal of the deposit, carried out between 2004 and 2006 (López Quintana and Guenaga 2006–2007), has revealed nine levels in which molluscs appear in varying quantities, from few remains in the Late Magdalenian and Azilian levels to considerable accumulations in the Mesolithic and Neolithic layers.

The excavation, done with modern methods, has enabled a detailed study of the material and, consequently, has revealed the evolution of mollusc exploitation throughout the Santimamiñe sequence (Gutiérrez Zugasti 2008).

The lithic material obtained by this recent archaeological work at Santimamiñe shows a clear quantitative decline in the Neolithic (levels Slm-Lsm) and Mesolithic (levels H-Sln) in comparison with the Azilian (level Arcp) and above all with the occupations during the Magdalenian (levels Slnc, Almp, and Csn-Camr; López Quintana et al. in press). However, as we have pointed out above, this striking reduction in quantity is common at sites in the region during the transition between the Pleistocene and the Holocene, such as at La Riera (Asturias; Straus and Clark 1986) and El Perro (Cantabria; González Morales and Díaz Casado 1992).

Material and Methods

The archaeological material that has been analyzed consists of nine mollusc shell fragments from the Neolithic levels Slm and Lsm. To be precise, from level Lsm, there are two hinge fragments of right valves, a fragment with the impression of the adductor muscle of a right valve, and an edge fragment, all of *Ostrea edulis* (Linné 1758). From the same level an edge fragment of *Patella* sp. and another of *Ruditapes decussatus* (Linné 1758) have also been analyzed. From level Slm, the

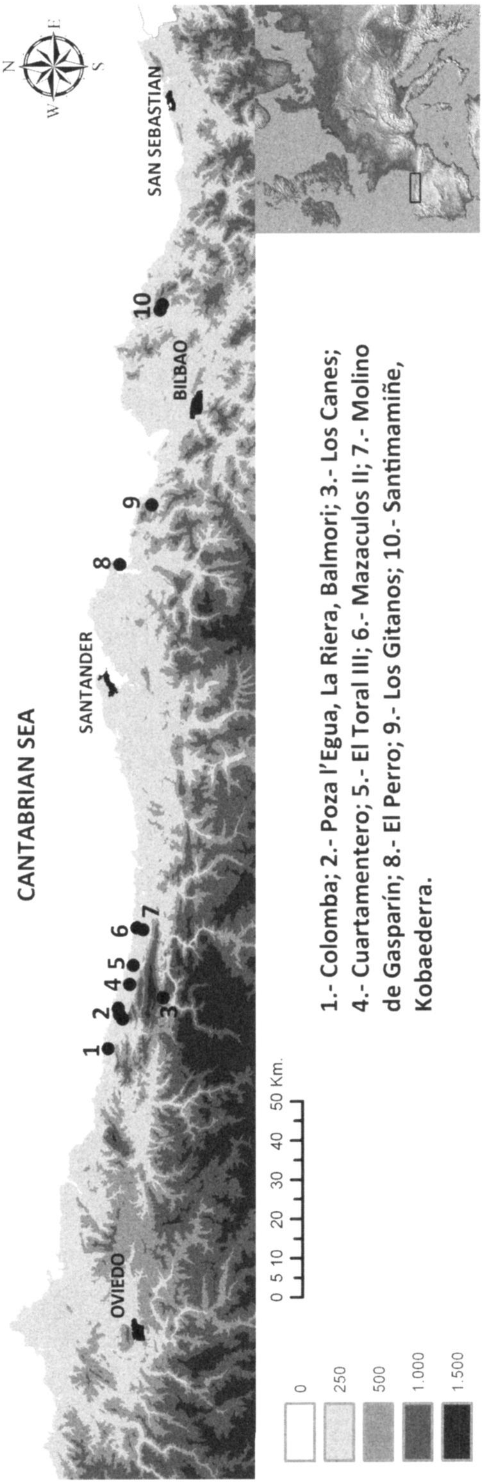

Figure 3. Location of the study area in northern Spain and the sites mentioned in the text.

fragments analyzed are a hinge fragment of a right valve and a fragment with the impression of the adductor muscle of a right valve, of *Ostrea edulis*, as well as a *Mytilus galloprovincialis* fragment (Lamarck 1819).

Of these nine shell fragments, seven were defined by microwear analysis as working implements (Cuenca 2009; Gutiérrez Zugasti et al. 2010).

In order to test the hypothesis proposed through the functional analysis of these remains, an experimental program was undertaken to characterize the use-wear exhibited by shell tools when they are used to carry out specific productive activities (Cuenca et al. 2010). This type of experiment has the aim of describing the use-wear marks that are generated on the shells, together with the definition of the processes that form them. This information is achieved by controlling certain variables, which are either unmodifiable (such as the substance being worked) or modifiable (the working action and its duration, or the working angle). By controlling the variables that are regarded as significant, the experiment becomes an analytical tool (González Urquijo and Ibáñez 1994:17).

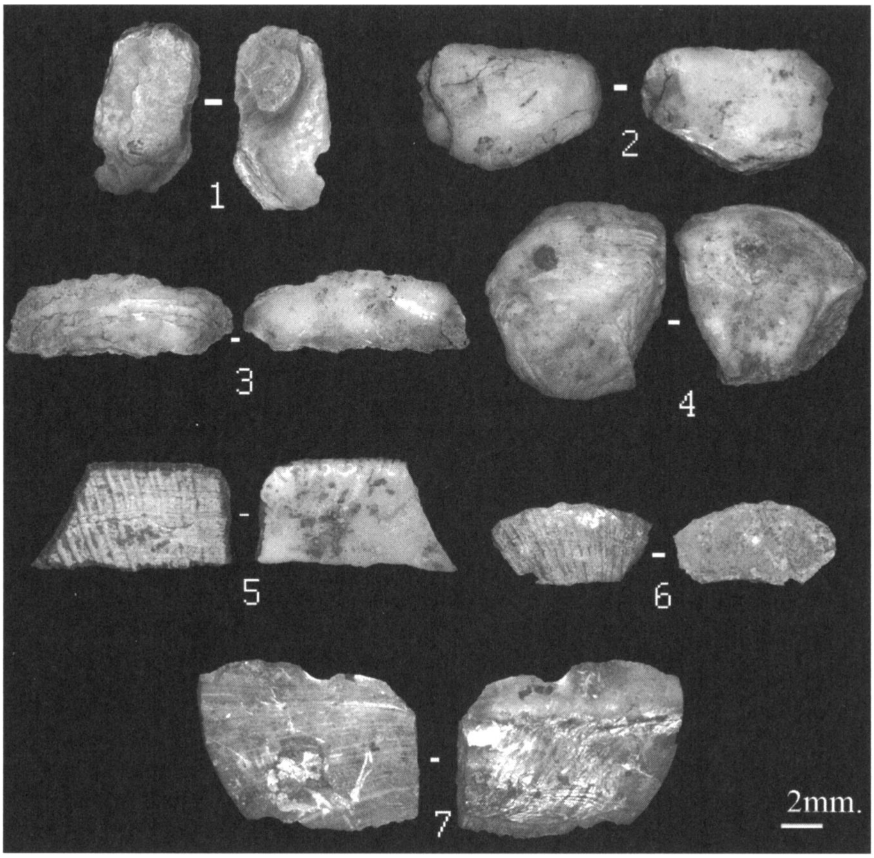

Figure 4. Shell tools from the Neolithic levels at Santimamiñe (Slm-Lsm): (1) hinge of *Ostrea edulis*, (2) impression of the adductor muscle of *Ostrea edulis,* (3) edge of *Ostrea edulis,* (4) impression of the adductor muscle of *Ostrea edulis,* (5) edge of *Ruditapes decussatus,* (6) edge of *Patella* sp., (7) edge of *Mytilus galloprovincialis*.

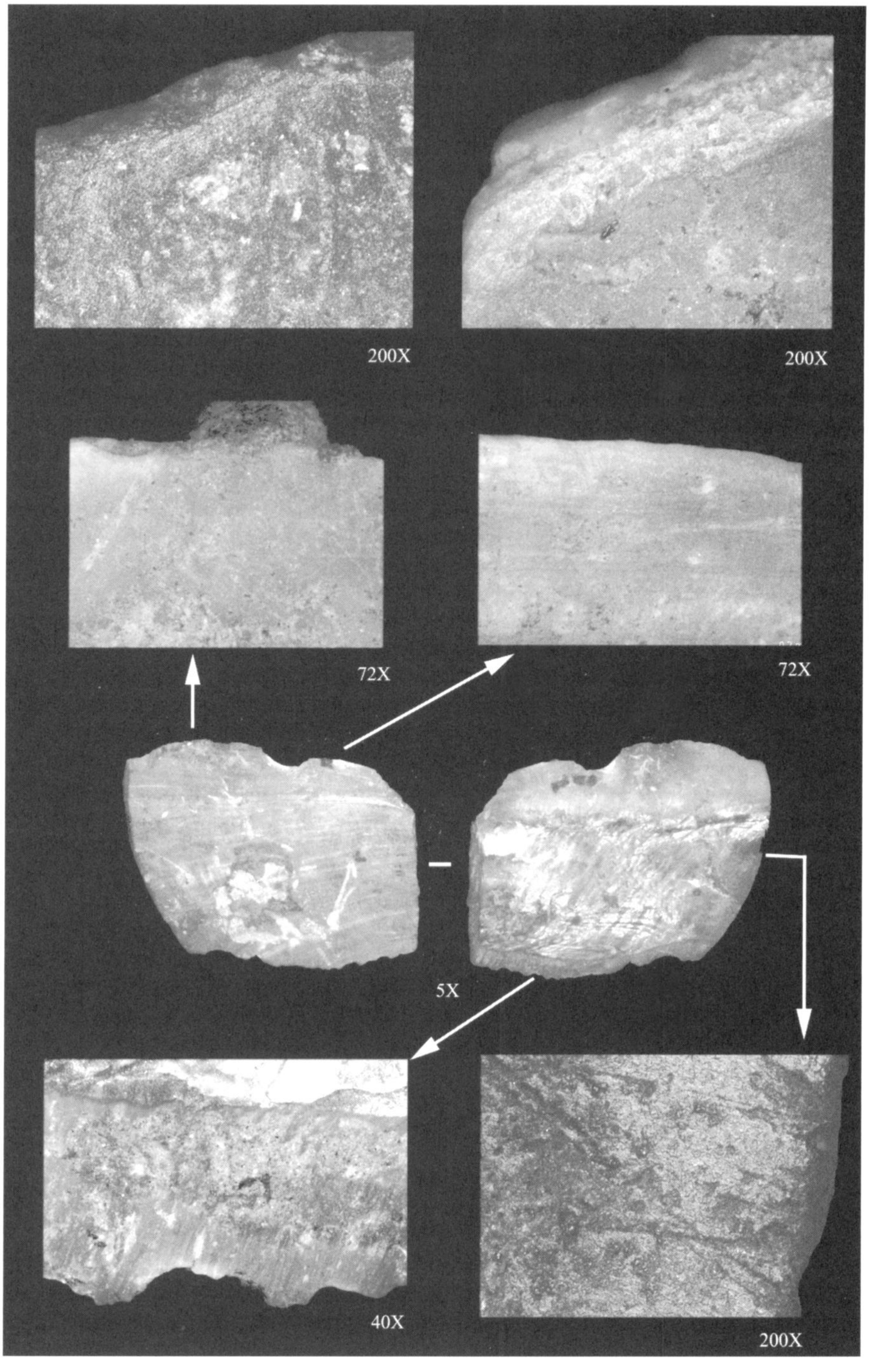

Figure 5. Fragment of *Mytilus galloprovincialis* shell with use-wear marks caused by contact with fairly abrasive animal material. In addition, the direction of the marks indicates scraping kinematics.

Based on the results of the functional analysis carried out on the malacological objects at Santimamiñe, the activities selected for the experimental program were the processing of wood, animal skins, plant fibers, and hides. The mollusc species chosen for the experiment were the same as the ones examined in the use-wear analysis, and which are found in different proportions in the assemblages at sites in northern Spain in the Mesolithic and early Neolithic (Gutiérrez Zugasti 2008). Therefore, their selection for the experiment was both rational and opportune, enabling the results of the experiment to be extrapolated to the study of other sites in the same area.

The working implements in the experimental program were first observed macroscopically, with a magnification of between 5 and 72.5×, in order to analyze and photograph larger marks, mainly rounding and chipping. Subsequently the pieces were viewed and photographed at between 100 and 200×, with a metallographic microscope, in order to analyze the micro-wear. The polished surfaces and the bottoms of the grooves were recorded with a duplicator inserted in the microscope, which allowed the observation and photography of these features at up to 400×.

The shells used in the experiment were cleaned in water before being analyzed and photographed, and if necessary, the active zones were wiped with a cotton puff impregnated with alcohol or naphtha to remove adhering particles and residue.

Before the experimental program was carried out, the taphonomic traits and natural alterations most commonly seen on the shells of each species were documented by recording and photographing shells that had been gathered but not used. This was aimed at differentiating any natural alterations seen on the shells from those caused by their use as implements.

The substances processed with the shell implements were fresh hazel wands (*Corylus avellana* Linné 1753), stems of fresh reeds (*Juncus* sp.), fresh lamb skin (*Ovis aries* Linné 1758), dry roe-deer skin (*Capreolus capreolus* Linné 1758), and strips of red-deer hide (*Cervus elaphus* Linné 1758). The following actions were performed: bidirectional transverse scraping action with the shells of *Ostrea edulis*, *Mytilus galloprovincialis*, and *Patella* sp., to remove fatty matter and remains of meat, and to thin fresh *Ovis aries* skin and dry *Capreolus capreolus* skin. Bidirectional transverse action was used to thin and tenderize strips of *Cervus elaphus* hide. A unidirectional transverse scraping action was used with the natural edge of *Ruditapes decussatus* to extract plant fibers from *Juncus* sp. The same shell species was used with a unidirectional transverse scraping action to remove the bark and to shape *Corylus avellana* wands. The only longitudinal kinematics used in the experiment were to cut the *Juncus* sp. plant fibers, using the edge produced by a percussion fracture of a *Ruditapes decussatus* shell. The application of force in all cases was through the pressure of the implement on the substance being worked.

The experiments were carried out in all cases with three time-spans of 5, 10, and 15 minutes. During the experiment, the contact angles approximated right angles (about 90º) in both the transverse and the longitudinal actions. In some cases they varied between 75º and 90º, but in the working of hide with the *Ostrea edulis* hinge, the surface of which is flat, the friction took place at a nearly flat angle (180º).

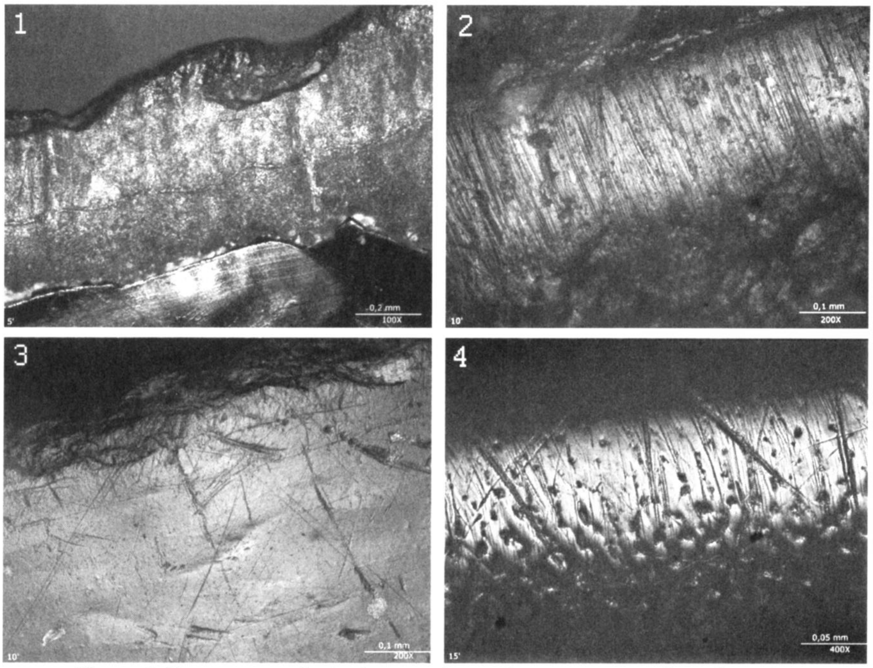

Figure 6. Use-wear marks in the experimental program: (1) edge of *Mytilus galloprovincialis* used to process dry skin for five minutes, at 100×; (2) hinge of *Ostrea edulis* used to process strips of hide for 10 minutes, at 200×; (3) edge of *Patella* sp. used to process dry skin for 10 minutes, at 200×; (4) edge of *Ruditapes decussatus* used to shape wooden sticks for 15 minutes, at 400×.

Results

The analysis of the shell fragments from Santimamiñe determined that seven of them had been used in the processing of different kinds of soft or medium-hard animal matter and in some cases of plant material (Gutiérrez Zugasti et al. in press). All the shell tools had been used with a transverse scraping action, in some cases alternating with longitudinal kinematics.

Three *Ostrea edulis* fragments had marks on one of the natural edges, and another had use-wear marks on the vertex of the hinge, which was noticeably rounded. This hinge displayed polishing characterized by heavy shading, a dull gloss, and a greasy appearance.

In the same way, two fragments of *Patella* sp. and *Mytilus galloprovincialis* shells showed signs of transverse action on one or two of their edges, respectively, caused by working an abrasive animal matter. Finally, a fragment of *Ruditapes decussatus*, with a highly rounded edge, displayed polishing with compact shading, and striations with a dark bottom, which are oblique and perpendicular to the edge. This fragment was identified as an implement used to process a plant rich in silica.

The results of the experimental program confirm the hypotheses that were proposed about the substances that were processed with the shell implements found at Santimamiñe. The findings suggest that the *Ruditapes decussatus* fragment was

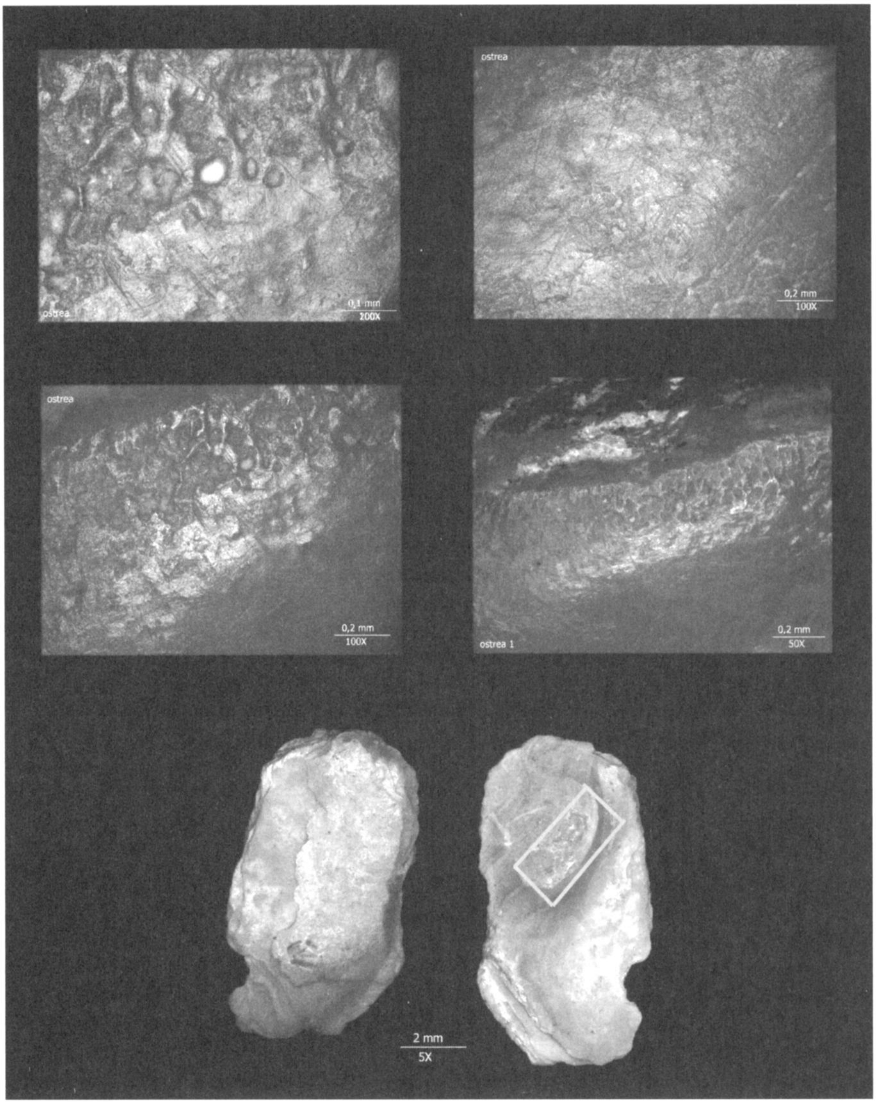

Figure 7. *Ostrea edulis* fragment with the impression of the adductor muscle, displaying use-wear marks: it is noticeably rounded and its surface shows micro-polish, a dull gloss and "greasy" appearance. Circular depressions and numerous fine, shallow striations, in different directions can also be seen, giving the polishing a rough appearance.

used to process a non-woody plant and was not used to work wood. However, despite the similarity in the use-wear marks described for the archaeological and the experimental materials, they are more developed in the archaeological items that have been analyzed. Therefore, the *Ruditapes decussatus* fragment from level Lsm at Santimamiñe was probably used to process a non-woody plant harder than *Juncus* sp., or it was used for a longer period than during the experiments. This latter possibility is very likely since the maximum duration of the tests in the experiment was only 15 minutes, and the implement was still perfectly suitable for continued processing.

With regard to the *Ostrea edulis* hinge with a rounded vertex, the experimental items used to tenderize small hide strips displayed very similar traits to those in the archaeological assemblage, although the use-wear was somewhat more developed in the experimental items. The degree of dryness (and therefore abrasiveness) of the hide may determine the depth of the marks, or the speed with which the marks develop.

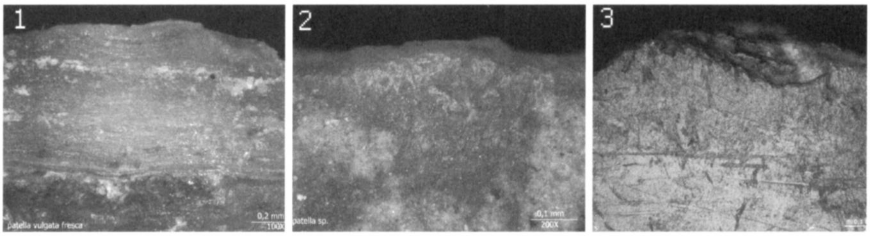

Figure 8. Comparison of *Patella* sp. shell surfaces: (1) surface of a *Patella* sp. shell collected in the beach in its natural state, at 100×; (2) surface of a *Patella* sp. shell from the deposit at Santimamiñe with use-wear marks, at 200×; (3) surface of a *Patella* sp. shell used in the experimental program to process dry skin for 5 minutes, at 200×.

The other shell fragments from Santimamiñe—three *Ostrea edulis* fragments with marks on one of the natural edges, and fragments of *Patella* sp. and *Mytilus galloprovincialis*—were interpreted as implements used to scrape soft or medium-hard animal matter. However, the experiments seem to suggest that they were probably used to process dry hide rather than fresh skin. Alternatively, some type of abrasive might have been used to tan the skin (such as ocher). This procedure has often been documented ethnographically; it does cause more developed marks, and therefore the implement surfaces display more striations.

This hypothesis is based on the development of diagnostic marks in both collections: the amount of polishing and the concentration of striations on the archaeological material more closely resembles the experimental material used to work dry hide. Dry hide is rather more abrasive than fresh skin, and causes more developed marks and, as we have seen, more abundant striations (Cuenca et al. 2010).

DISCUSSION

The use of information from ethnography and anthropology in archaeological studies has provoked discussion since the 1970s. In America, various studies appear to have resolved this debate definitively (Gould 1978; Kramer 1979), whereas in Europe the contribution that this kind of information can make has been a more recent topic of discussion (Estévez and Vila 1995; Gándara 2006; Mansur 2006; Manzi and Spikins 2008).

Our findings described here constitute a contribution to the available information about the use of shells as tools in productive processes, and this is the first time this kind of use has been identified in northern Spain. This use, as we shall see, is on occasion clearly comparable with the kinds of activities for which shells have been used in many ethnographical accounts, processing similar types of materials. In addition, this evidence could partly explain the scarcity of lithic and bone tools at many Mesolithic and early Neolithic sites in northern Spain. It may complete the technological range employed by some of these hunter-gatherer groups to carry out activities related to the exploitation of coastal resources.

The methodological shaping of an experimental program, the basis of the development of the use-wear analysis of productive tools, should be founded first on the productive activities as shown implicitly or explicitly by the archaeological contexts in the geographical area of the study. In parallel with this, the design of the experimental program should be coherent with the natural resources (malacological resources, in this case) used as raw materials in the geographical context defined by the research program. Certainly, this factor prevents at the outset the erroneous application, as a direct analogy, of information from archaeological studies carried out in contexts with very different biotopes. Despite this, we believe that a wide knowledge of the technological use of shells, as recorded ethnographically, could provide decisive background data to encourage and stimulate the formulation of appropriate methodological hypotheses for the questions being asked. In the case of northern Spain, the contributions made by ethnographic information about the technological use of shells have assisted in the development of analytical mechanisms with which to tackle concrete problems in a restricted geographical area, but probably (and in parallel) the use of this information allows these same mechanisms to be validated in other geographical and chronological contexts, thus laying down a more solid foundation on which to construct a methodology of analysis. The documentation of ethnographic information has been used to formulate a working hypothesis during the planning of an experimental program (Cuenca 2009) to contextualize the results of use-wear analysis carried out on several shell tools (Gutiérrez Zugasti et al. in press). In fact, the eabundant ethnographic information in the literature shows the suitability of shells for use as tools in numerous productive processes carried out by different human groups. In this respect, some of the activities performed by these groups, and to a lesser degree some of the mollusc species used as tools, are similar to those recorded in Mesolithic and early Neolithic contexts in northern Spain.

For instance, we can highlight the suitability of species belonging to the *Mytilus* genus (mussel species found at many archaeological sites in the north of Spain) for scraping tasks, as well as the numerous examples that have been recorded of the use of shells in activities such as processing hides and wood, or preparing meat and fish—tasks that are represented in Mesolithic and early Neolithic contexts in northern Spain and at many different coastal archaeological sites all over the world. The large amount of information available about the many uses given to mollusc shells, among a varied and wide range of human groups, in different geographical and chronological settings, should make us reflect on the almost exclusive consideration as food resources and ornamentation that has traditionally been given to malacological remains in most coastal archaeological contexts, particularly in the case of research undertaken in Europe. To the abundant information about the use of these kinds of tools among different human groups, we can add the functional potential of some shell tools shown by experimental programs (e.g., Cuenca 2009; Cuenca et al. 2010; Lammers-Keijsers 2008; Mansur and Clemente 2009; Toth and Woods 1989).

The steady increase in reporting this kind of evidence at European archaeological sites (Cade 1991; Cristiani et al. 2005; Gutiérrez Zugasti et al. in press; Vigié 1987, 1992, 1995; Vigié and Courtin 1986, 1987) will very probably expand further with the development of a specific methodology for the analysis of these types of working tools, as well as through the spread of this type of analysis to other coastal contexts.

However, it is equally true that until now no systematic functional research has been undertaken on shells. The lack of a well-established, specific analytical methodology for this type of material, together with the great importance given to lithic tools in archaeological studies, has meant that other raw materials, including molluscs, have been undervalued as to their potential use in productive processes (Mansur and Clemente 2009). Presently we can neither extend these results to the general interpretation of coastal sites in the north of Spain nor rule out the likelihood that these types of tools might be found at other sites, since microwear analysis has yet to be applied to many of the assemblages. In any case, we should not isolate this technology from the other means of production used by hunter-gatherer groups for the same aim. Therefore, once it has been shown that this kind of technological use of shells has also been employed at other sites, it would be interesting to relate this use with aspects such as the availability of good-quality lithic raw materials, or the differential use of each kind of material, such as stone, bone, antler and shell, in specific productive processes. In this respect, differentiated use of each tool material has been documented in certain contexts (Charpentier et al. 2004). However, in other cases in which use-wear analysis has been carried out on the whole tool assemblage, both lithic and shell, the results seem to suggest both technologies were used for very similar activities (Lammers-Keijsers 2008). Finally, in still other contexts, the use of mollusc shells has been interpreted as a solution in situations where good-quality lithic raw material is unavailable (Schmidt et al. 2001).

CONCLUSIONS

To date, the documentation of this type of evidence in northern Spain is limited to the seven tools recovered from the deposit at the cave of Santimamiñe (Kortezubi, Vizcaya). Thus, taking into account that the evidence documented so far corresponds to an area (the eastern part of northern Spain) exhibiting greater availability of high-quality lithic raw materials for knapping than the western sector, the hypothesis about the role that shell implements might have played in carrying out productive activities at coastal sites in the western area, in both the Mesolithic and the early Neolithic, is strengthened even further (Cuenca 2009).

Although we are unable to reach definitive conclusions about these questions in our area of study, it seems likely that such an abundant raw material, perhaps already brought to the settlement as a food resource, could greatly reduce the work involved in the provision of other raw materials, as well as the subsequent process of manufacture or shaping, when shells are used without further modification (Cuenca 2009). At the same time, the use of an implement that does not require any kind of repair (Castro et al. 1999:51) to maintain its effective functionality would have been an advantage in comparison with lithic tools, because as soon as the functionality of the shell implement began to decline, it could rapidly and cheaply be replaced with another one.

In this respect, we believe that the technological use of shells could have modified certain behavioral patterns of the human groups in connection with the processes of manufacturing their tools, and by extension with other productive processes. These would probably have been influenced by such aspects as the availability of good-quality raw materials in the local area, or the need to move long distances or develop a network of social relationships for the provision of the lithic resources needed to make their tools (Cuenca 2009).

In the future, as other archaeological sites and assemblages are studied, any identification of the use of shells as tools may help to explain the puzzling scarcity of lithic and bone assemblages at some Mesolithic and early Neolithic sites in the north of Spain. It will then be necessary to reappraise the role of shells in these societies, taking into account that the malacological resources may not only have been used as food and in ornamentation, but also as tools with which certain productive processes were carried out. It will be necessary to develop specific methodologies enabling the study of this type of evidence by applying use-wear analysis (Semenov 1964). The combination of both factors could contribute to greatly increasing our knowledge about these coastal groups of hunter-gatherers. This type of technological evidence could be extended to other areas outside northern Spain by developing specific analytical methodologies based on traceology, and also by enlarging our knowledge about the functional potential shells may have as working tools through the possibilities offered by ethnographical documentation.

NOTE

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REFERENCES CITED

Allen, M. S. 1996. Style and function in East Polynesian fish-hooks. *Antiquity* 70:97–116.

Aranzadi, T. de, J. M. Barandiarán, and E. Eguren. 1931. “Exploraciones en la caverna de Santimamiñe (Basondo: Cortézubi). 2ª Memoria. Los niveles con cerámica y el conchero," in *Obras completas de José Miguel de Barandiarán IX*. Edited by J. M. de Barandiarán, pp. 91–243. Bilbao: La Gran Enciclopedia Vasca.

Aranzadi, T. de, and J. M. Barandiarán. 1935. "Exploraciones en la caverna de Santimamiñe (Basondo: Cortézubi). 3ª Memoria. Yacimientos azilienses y paleolíticos," in *Obras completas de José Miguel de Barandiarán IX*. Edited by J. M. de Barandiarán, pp. 245–344. Bilbao: La Gran Enciclopedia Vasca.

Arias, P. 1992a. "Estrategias de aprovechamiento de las materias primas líticas en la costa oriental de Asturias," in *Tecnología y cadenas operativas líticas*. Edited by R. Mora, X. Terradas, X. Parpal, and C. Plana, pp. 37–55. Treballs d'Arqueología 1. Barcelona: Departament d'Història de les Societats Pre-capitalistes i d'Antropologia Social.

———. 1992b. "Adaptaciones al medio natural de las sociedades humanas de la región cantábrica durante el Boreal y el Atlántico," in *The Late Quaternary in the Western Pyrenean Region*. Edited by A. Cearreta and F. M. Ugarte, pp. 269–83. Vitoria-Gasteiz: Universidad del País Vasco.

Arias, P., and M. A. Fano. 2003. "Shell middens and megaliths: Mesolithic funerary contexts in Cantabrian Spain and their relation to the Neolithic," in *Stones and bones: Formal disposal of the dead in Atlantic Europe during the Mesolithic-Neolithic interface, 6000–3000 BC*. Edited by G. Burenhult, pp. 145–166. Oxford: BAR International Series Archaeopress 1201.

Arias, P., and C. Pérez. 1992. "Las excavaciones arqueológicas en la cueva de Los Canes (Arangas, Cabrales). Campañas de 1987 a 1990," in *Excavaciones arqueológicas en Asturias 1987–90*. Edited by J. Fortea, pp. 95–101. Oviedo: Consejería de Educación, Cultura, Deportes y Juventud de Principado de Asturias.

———. 1995. "Excavaciones arqueológicas en Arangas, Cabrales (1991-1994). Las cuevas de Los Canes, El Tiu Llines y Arangas," in *Excavaciones arqueológicas en Asturias, 1991–94*. Edited by J. Fortea, pp. 79–92. Asturias: Consejería de Educación, Cultura, Deportes y Juventud de Principado de Asturias.

Barandiarán, J. M. de. 1961. "Exploraciones en la caverna de Santimamiñe (Basondo: Cortézubi): 4ª Memoria. Campaña de 1960," in *Obras completas de José Miguel de Barandiarán IX*. Edited by J. M. de Barandiarán, pp. 345–68. Bilbao: La Gran Enciclopedia Vasca.

———. 1962. "Exploraciones en la caverna de Santimamiñe (Basondo: Cortézubi):5ª Memoria. Campaña de 1961," in *Obras completas de Barandiarán IX*. Edited by J. M. de Barandiarán, pp. 369–403. Bilbao: La Gran Enciclopedia Vasca.

———. 1963. "Exploraciones en la caverna de Santimamiñe (Basondo: Cortézubi): 6ª Memoria. Campaña de 1962," in *Obras completas de Barandiarán IX*. Edited by J. M. de Barandiarán, pp. 405–19. Bilbao: La Gran Enciclopedia Vasca.

Binford, L. W. 1998. *En busca del pasado: Descifrando el registro arqueológico*. Barcelona: Crítica.

Cade, C. 1991. *Contribution à l'étude de la malacofaune marine de la Villa Giribaldi (Nice, Alpes Maritimes)*. Memoire de Maîtrise d'Histoire de l'Art et d'Archéologie. Universidad de Provence, Aix-Marseille I.

Castro, P. V., S. Gili, V. Lull, R. Micó, C. Rihuete, R. Risch, and M. E. Sanahuja. 1999. Teoría de la producción de la vida social. Mecanismos de explotación en el sudeste ibérico. *Boletín de Antropología Americana* 33:25–77.

Charpentier, V., S. Mery, and C. Phillips. 2004. Des coquillages . . . outillages des Ichtyophages? Mise en évidence d'industries sur Veneridae, du Néolithique à l'âge du Fer (Yemen, Oman, E.A.U.). *Arabian Archaeology and Epigraphy* 15:1–10.

Choi, K. and Driwantoro, D. 2007. Shell tool use by early members of *Homo erectus* in Sangiran, central Java, Indonesia: Cut mark evidence. *Journal of Archaeological*

Science 34:48–58.

Claassen, C. 1998. *Shells*. Cambridge: Cambridge University Press.

Clark, G. 1976. *El Asturiense Cantábrico*. Bibliotheca Prehistórica Hispana 13. Madrid: CSIC Instituto Español de Prehistoria.

Clemente, I. 1995. *Instrumentos de trabajo líticos de los Yámanas (Canoeros-nómadas de la Tierra del Fuego): una perspectiva desde el análisis funcional.* Unpublished PhD dissertation, Departament d'Antropologia Social i Prehistoria, Universitat Autonoma de Barcelona.

———. 1997. *Los instrumentos líticos de Tunel VII: una aproximación etnoarqueológica.* CSIC-UAB Treball d'Etnoarqueología 2. Barcelona.

Córdova Medina, A. 1991. Estudio de la industria de concha del residuario preagroalfarero El Mango, río Cauto, provincia Granma, Cuba. *Estudios Arqueológicos* 1989:85–108. Havana: Editorial Academia.

Cristiani, E., C. Lemorini, F. Martini, and L. Sarti. 2005. "Scrapers of *Callista chione* from Grotta del Cavallo (Middle Paleolithic cave in Apulia): Evaluating use-wear potential," in *From hooves to horns, from mollusc to mammoth: Manufacture and use of bone artefacts from prehistoric times to the present.* Edited by H. Luik, A. Chayke, C. Batey, and L. Lougos, pp. 319–24. Proceedings of the 4th meeting of the ICAZ Worked Bone Research Group at Tallin, 26–31 August 2003. Tallin: Tallin Book Printers.

Cuenca, D. 2009. *Las "tecnologías invisibles" en los grupos de cazadores recolectores del litoral durante los inicios del Holoceno (9.500–5.000 uncal BP) en la región Cantábrica. Utilización de las conchas de molusco en la realización de actividades productivas.* Unpublished MA thesis, Universidad de Cantabria.

Cuenca, D., I Clemente, and I. Gutiérrez Zugasti. 2010. Utilización de instrumentos de concha durante el Mesolítico y Neolítico inicial en contextos litorales de la región cantábrica: Programa experimental para el análisis de huellas de uso en materiales malacológicos. *Trabajos de Prehistoria* 67:211–25.

Dacal Moure, R., and M. Rivero de le Calle. 1984. *Arqueología aborigen de Cuba.* Havana: Editorial Gente Nueva.

De Lumley, H. 1969. *Le paléolithique inférieur et moyen du midi méditerranéen dans son cadre geologique.* Tome I: Ligurie-Provence. Paris: Editions du Centre National de la Recherche Scientifique.

Dupont, C. 2003. *La malacofaune de sites mésolithiques et néolithiques de la façade atlantique de la France: contribution à l'économie et à l'identité culturelle des groupes concernés.* Unpublished PhD dissertation,Université Paris I.

———. 2006. *La malacofaune des sites mésolithiques et néolithiques de la façade atlantique de la France. Contribution à l'economie et à l'identité culturelle des groupes concernés.* Oxford: BAR International Series 1571.

Emperaire, J. 1958. *Los nómadas del mar.* Santiago, Chile: Lom Ediciones.

Estévez, J., and A. Vila, eds. 1995. *Encuentros en los conchales fueguinos.* Treballs d'etnoarqueología 1. Barcelona: CSIC-UAB.

Gándara, M. 2006. "La inferencia por analogía: más allá de la analogía etnográfica," in *Etnoarqueología de la prehistoria: más allá de la analogía.* Pp. 13–23. Barcelona: Departament d'Arqueologia i Antropologia Institució Milá i Fontanals.

Gassiot Ballbè, E. 2001a. Adaptación ecológica y formaciones cazadoras recolectoras del Paleolítico Superior Final y Mesolítico en la Península Ibérica: Revisión crítica. *Revista Atlántica-Mediterránea de Prehistoria y Arqueología Social* IV:61–90.

———. 2001b. *Anàlisi arqueològica del canvi cap a lexplotació del litoral.* Unpublished PhD dissertation, Departament d'Antropologia Social i Prehistoria, Universitat Autonoma de Barcelona.

———. 2002. "Análisis funcional y producción en las sociedades cazadoras-recolectoras. Significación de los cambios tecnológicos durante el Mesolítico," in *Análisis funcional: su aplicación al estudio de sociedades prehistóricas. (1er Congreso de Análisis Funcional en España y Portugal)*. Edited by I. Clemente, R. Risch, and J. F. Gibaja. Oxford: BAR International Series 1073.

González Morales, M. R. 1982. *El Asturiense y otras culturas locales. La explotación de las áreas litorales de la región cantábrica en los tiempos epipaleolíticos*. Santander: Centro de investigación y museo de Altamira 7.

———. 1995a. "La transición del Holoceno en la Región Cantábrica: El contraste con el modelo mediterráneo español," in *Los últimos cazadores: Transformaciones culturales y económicas durante el Tardiglaciar y el inicio del Holoceno en el ámbito mediterráneo*. Edited by V. Villaverde Bonilla, pp. 63–78. Alicante: Instituto de Cultura "Juan Gil-Albert."

———. 1995b. "Memoria de los trabajos de limpieza y toma de muestras en los yacimientos de las cuevas de Mazaculos y El Espinoso (La Franca, Ribadeva) y La Llana (Andrín, Llanes) en 1993," in *Excavaciones arqueológicas en Asturias, 1991–94*. Edited by J. Fortea, pp. 65–78. Asturias: Consejería de Educación, Cultura, Deportes y Juventud de Principado de Asturias.

González Morales, M. R., and Y. Díaz Casado. 1992. Excavaciones en los abrigos de la Peña del Perro (Santoña, Cantabria). Estratigrafía, cronología y comentario preliminar de sus industrias. *Veleia* 8–9:43–64.

González Morales, M. R., L. G. Straus, A. Diez Castillo, and J. Ruiz Cobo. 2004. Postglaciar coast and inland: The Epipaleolithic-Mesolithic-Neolithic transitions in the Vasco-Cantabrian region. *Munibe* 56:61–78.

González Urquijo, J. E., and J. J. Ibáñez Estévez. 1994. *Metodología de análisis funcional de instrumentos tallados en sílex*. Bilbao: Universidad de Deusto Cuadernos de Arqueología 14.

Gould, R. A., ed. 1978. *Explorations in ethnoarchaeology*. Albuquerque: University of New Mexico Press.

Greenwood, R. S. 1978. "Obispeño and Purisimeño Chumash,"in *Handbook of the North American Indians*, vol. 8: *California*. Edited by R. E. Heizer, pp. 520–23. Washington, DC: Smithsonian Institution.

Gruet, Y. 1993. Les coquillages marins: objets archéologiques à ne pas négliger. Quelques exemples d'exploitation et d'utilisation dans l'Ouest de la France. *Revue Archéologique de l'Ouest* 10:157–61.

Guarch, J. M., 1973. *El ajuar no-cerámico de los Tainios de Cuba*. Havana: Academia de Ciencias de Cuba, Instituto de Arqueología, Serie Arqueología 3.

Gusinde, M. 1986. *Los Indios de Tierra de Fuego: Los Yámana*, Tomo II. Buenos Aires: Centro Argentino de Etnología Américana, CONICET.

Gutierrez Zugasti, F. I. 2008. *La explotación de moluscos y otros recursos litorales en la Región Cantábrica durante el Pleistoceno Final y Holoceno Inicial*. Unpublished PhD dissertation, Universidad de Cantabria.

Gutiérrez Zugasti, F. I., D. Cuenca Solana, I. Clemente Conte, C. González Sainz, and J. C. López Quintana. (in press) "Instrumentos de trabajo y elementos de adorno en conchas de molusco de la cueva de Santimamiñe (Kortezubi, Bizkaia)," in *Excavaciones en la cueva de Santimamiñe. Campañas 2004–2006*. Edited by J.C. López Quintana. Gobierno Vasco.

Henshilwood, C., P. Nilssen, and J. Parkington. 1994. Mussel drying and food storage in the Late Holocene, SW Cape, South Africa. *Journal of Field Archaeology* 21:103–9.

Izquierdo Díaz, G. 1991. La industria de la concha del sitio arqueológico El Paraiso, Santiago de Cuba. *Estudios Arqueológicos 1989*:141–89. Havana: Editorial Academia.

Jerardino, A. 1998. Excavations at Pancho Kitchen Midden, Western Cape Coast, South Africa. Further observations into the Megamidden period. *South Africa Archaeological Bulletin* 53 (167):16–25.

Johnson, P. J. 1978. "Patwin," in *Handbook of the North American Indians,* vol. 8: *California.* Edited by R. E. Heizer, pp. 350–60. Washington, DC: Smithsonian Institution.

Jones O'Day, S., and W. F. Keegan. 2001. Expedient shell tools from the northern West Indies. *Latin American Antiquity* 12:274–90.

Kramer, C., ed. 1979. *Ethnoarchaeology: Implications of ethnography for archaeology.* New York: Columbia University Press.

Lammers-Keijsers, Y. 2008. *Tracing traces from present to past: A funtional analysis of pre-Columbian shell and stone artefacts from Anse á la Gourde and Morel, Guadaloupe, FWI.* Leiden, The Netherlands: University Press.

Leroi-Gourhan, A. 1945. *El hombre y la materia. Evolución y técnica I.* Madrid: Ediciones Taurus.

Linares Villanueva, E. 2005. Las conchas de moluscos en Mesoamérica. *Lakamha* 17:8–12.

López Quintana, J. C., and A. Guenaga. 2006–2007. Avance a la secuencia estratigráfica de la cueva de Santimamiñe (Kortezubi), tras la revisión de su depósito arqueológico en las campañas de 2004 a 2006. *KREI* 9:73–103.

López Quintana, J. C., A. Guenaga Lisazu, and A. Sáenz de Buruaga Blázquez. (in press) "Dinámica evolutiva de la industria lítica tallada en la secuencia estratigráfica de Santimamiñe. Campañas de 2004 a 2006," in *Excavaciones en la cueva de Santimamiñe. Campañas 2004-2006.* Edited by J. C. López Quintana. Vitoria-Gasteiz: Gobierno Vasco.

Mansur, M. E. 2006. "Los unos y los otros. El uso de fuentes etnográficas y etnohistóricas," in *Etnoarqueología de la Prehistoria: más allá de la analogía.* Pp. 315–36. Barcelona: Departament d'Arqueologia i Antropologia Institució Milá i Fontanals.

Mansur, M. E., and I. Clemente. 2009. "¿Tecnologías invisibles? Confección, uso y conservación de instrumentos de valva en Tierra del Fuego," in *Arqueología Argentina en los inicios de un nuevo siglo,* vol. 2. Edited by F. Oliva, N. de Grandis, and J. Rodríguez, pp. 359–67. Universidad Nacional de Rosario, Argentina.

Manzi, L. M. and Spikins, P.A. 2008. El fuego en las altas latitudes: Los Selk'nam de Tierra de Fuego como referente etnográfico para el Mesolítico europeo. *Complutum* 19:79–96.

Marquardt, W. H., and C. Payne. 1992. *Culture and environment in the domain of the Calusa.* Miami: Institute of Archaeology and Paleoenvironmental Studies, University of Florida.

Méry, S., V. Charpentier, and M. Beech. 2008. First evidence of shell fish-hook technology in the Gulf. *Arabian Archaeology and Epigraphy* 19:15–21.

Moore, C. B. 1921. Notes on shell implements from Florida. *American Anthropologist* 23:12–18.

Ontañón, R. 2005. "La secuencia de la Cueva de Los Gitanos (Castro Urdiales, Cantabria) y el Neolítico cantábrico," in *III Congreso del Neolítico en la Península Ibérica.* Edited by P. Arias, R. Ontañón, and C. García-Moncó, pp. 1035–43. Santander: Monografías del Instituto Internacional de Investigaciones Prehistóricas Servicio de Publicaciones, Universidad de Cantabria.

Prous, A. 1992. Os moluscos e a arqueologia brasileira. *Arquivos do Museu de História Natural* 11:241–98.

Rodríguez, A., and J. F. Navarro. 1999. La industria malacológica de la cueva de El Tendal

(San Andrés y Sauces, isla de La Palma). *Vegueta* 4:75–100.

Semenov, S. A. 1964. *Prehistoric technology*. London: Cory Adams and Mackay.

Schmidt, L., A. Anderson, and R. Fullagar. 2001. Shell and bone artefacts from the Emily Bay Settlement site, Norfolk Island. *Records of the Australian Museum Supplement* 27:67–74.

Smith, A., and J. Allen. 1999. "Pleistocene shell technologies: Evidence from Island Melanesia," in *Australian coastal antiquity*. Edited by J. Hall and I. McNiven. Department of Archaeology and Natural History, Australian Universal University.

Straus, L. G. 1979. Mesolithic adaptations along the northern coast of Spain. *Quaternaria* 21:305–27.

———. 1996. "The use of quartzite in the Upper Paleolithic of Cantabrian Spain," in *Non-flint-stone tools and the Paleolithic occupation of the Iberian Peninsula*. Edited by N. Maloney, L. Raposo, and M. Santonja, pp. 37–41. Oxford: British Archaeological Reports S-649.

Straus, L. G., and G. A. Clark, eds. 1986. *La Riera cave: Stone-age hunter-gatherer adaptations in northern Spain*. Anthropological Research Papers 36. Tempe: Department of Anthropology, Arizona State University.

Suárez, L. 1974. *Técnicas prehispánicas en los objetos de concha*. México: Instituto Nacional de Antropología e História SEP Colección Científica Arqueología.

Szabó, K. 2008. Shell as a raw material: Mechanical properties and working techniques in the tropical Indo-West Pacific. *Archaeofauna* 17:125–38.

Szabó, K., B. Adam, and P. Bellwood. 2007. Shell artefact production at 32.000–28.000 BP in Island Southeast Asia. Thinking across media? *Current Anthropology* 48:701–23.

Toth, N., and M. Woods. 1989. Molluscan shell knives and experimental cut-marks on bones. *Journal of Field Archaeology* 16:250–55.

Vega del Sella, C. 1930. *Las cuevas de la Riera y Balmori (Asturias)*. Madrid: Comisión de Investigaciones Paleontológicas y Prehistóricas, Museo Nacional de Ciencias Naturales 38.

Vigié, B. 1987. Essai d'étude methodologique d'outils sur coquillages de la grotte de Camprafaud (Ferrières-Poussarou, Hérault). *L'Antropologie* 91(1):253–72.

———. 1992. *Recherches sur l'exploitation des ressources aquatiques dans le midi Mediterraneen Français au Postglaciaire*. Unpublished PhD dissertation, Universite de Provence (Aix-Marseille).

———. 1995. "Du déchet alimentaire à l'objet coquillier: le statut des coquillages en milieu archéologique," in *L'Homme préhistorique et la mer*. 120e Congrés National des Sociétés Savantes (Aix-en-Provence, 1995). Edited by G. Camps, pp. 351–54. Paris.

Vigié, B., and J. Courtin. 1986. Les outils sur coquilles marines dans le Neolithique du midi de la France. *Mesogée* 46:51–61.

———. 1987. Le problème des coquillages à bord dentelé dans la préhistoire du midi de la France. *Mesogée* 47:93–98.

Zapata Peña, L., J. J. Ibáñez Estévez, and J. E. González Urquijo. 1997. El yacimiento de la cueva de Kobaederra (Oma, Kortezubi, Bizkaia). Resultados preliminares de las campañas de excavación 1995-97. *Munibe* 49:51–63.